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[54] **ROOM AIR CONDITIONER HAVING INLET AND OUTLET CLOSURES AND METHODS FOR THEIR OPERATION**

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[73] Assignee: **Samsung Electronics Co., Ltd.**, Suwon, Rep. of Korea

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Aug. 22, 1996	[KR]	Rep. of Korea	1996 34869
Aug. 22, 1996	[KR]	Rep. of Korea	1996 34870
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Aug. 22, 1996	[KR]	Rep. of Korea	1996 34872
Aug. 22, 1996	[KR]	Rep. of Korea	1996 34873
Aug. 22, 1996	[KR]	Rep. of Korea	1996 34874
Aug. 28, 1996	[KR]	Rep. of Korea	1996 36084

[51] **Int. Cl.**[6] **F25B 49/00**

[52] **U.S. Cl.** **62/89**; 62/131; 62/180; 454/236; 454/256

[58] **Field of Search** 62/89, 131, 180, 62/186, 408, 409, 262; 318/264, 265, 266, 267, 282, 286, 468; 454/236, 239, 296, 324; 236/49.3; 340/524, 686

[56] **References Cited**

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Primary Examiner—Harry B. Tanner
Attorney, Agent, or Firm—Burns, Doane, Swecker & Mathis, L.L.P.

[57] **ABSTRACT**

A room air conditioner includes an air inlet, an air outlet, a heat exchanger disposed between the inlet and outlet, and an air circulation fan. The inlet is opened and closed by motor-driven inlet vanes. The outlet is opened and closed by a vertically slidable motor-driven door. Air direction control vanes extend across the outlet for varying the direction of discharged air. Before the door is either opened or closed, the air control vanes are automatically swung upwardly to a clearance position to avoid interfering with movement of the door. When the inlet and outlet are to be closed, the inlet vane motor is actuated prior the door motor to ensure that the inlet and outlet are fully closed simultaneously, even though it takes longer for the inlet vanes to travel to their fully closed state. A sensor determines when the door reaches an almost-closed state, and the door motor continues to operate for a set period thereafter to ensure that the door becomes fully closed.

22 Claims, 12 Drawing Sheets

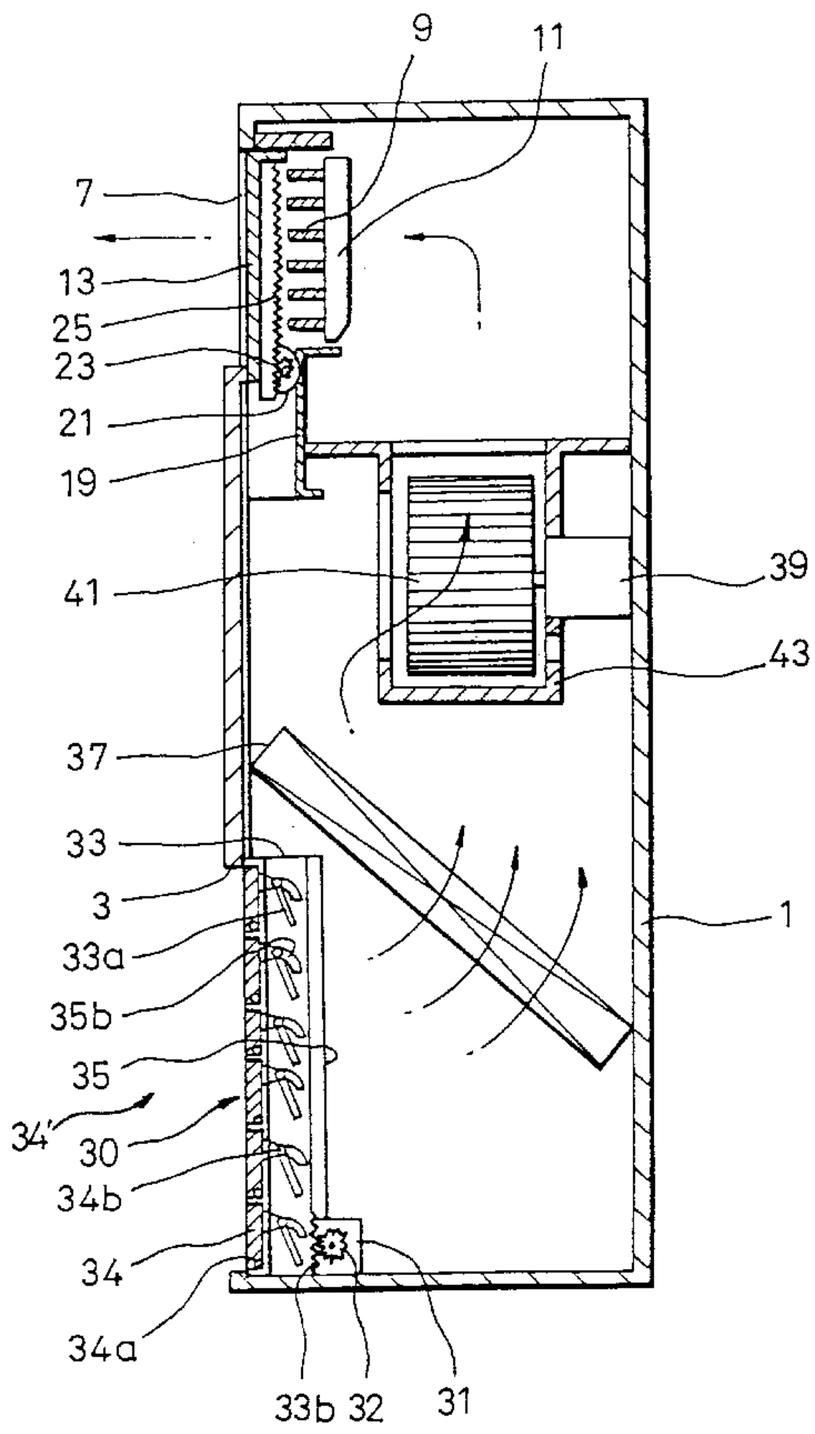


FIG.1

(PRIOR ART)

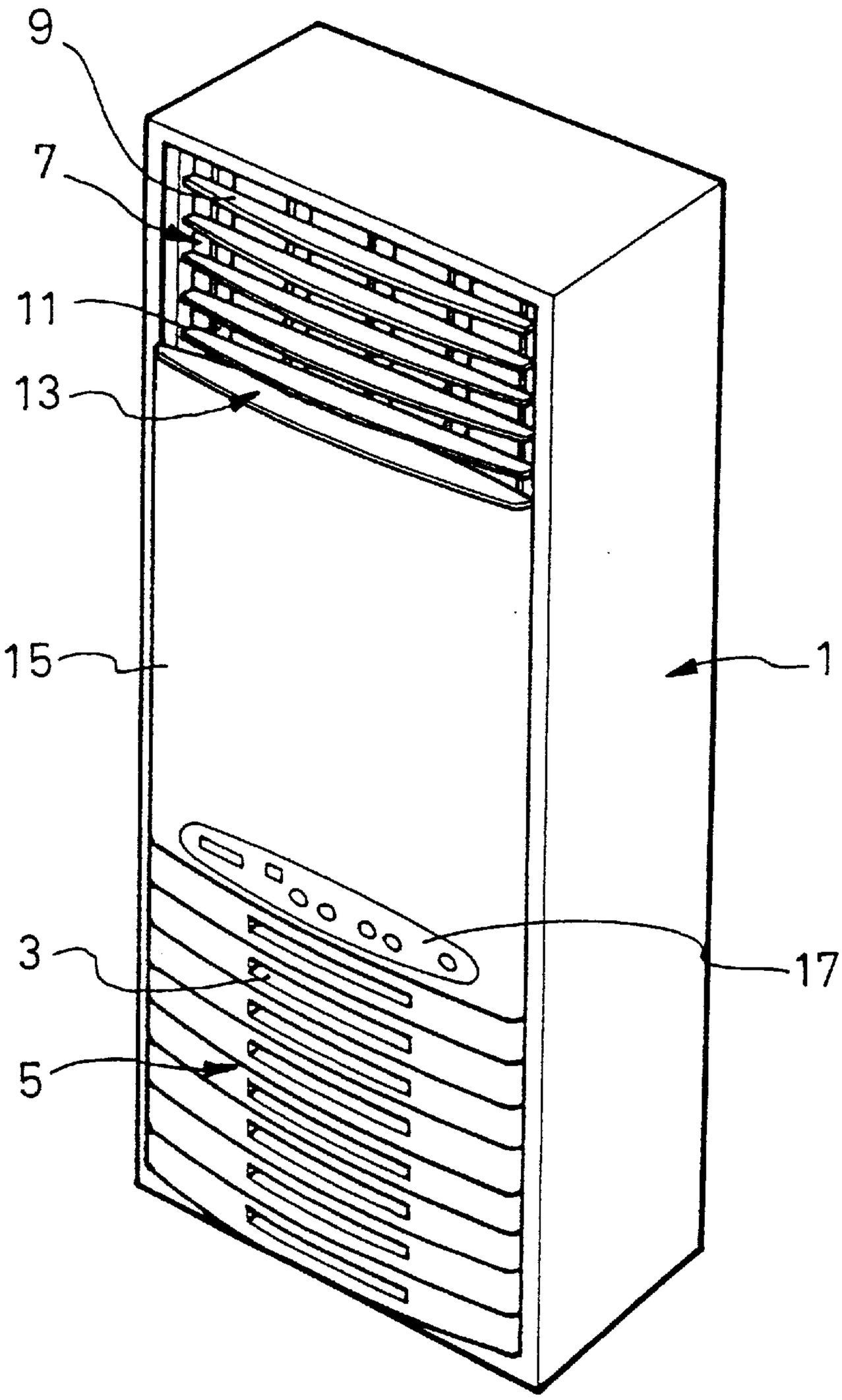


FIG.2

(PRIOR ART)

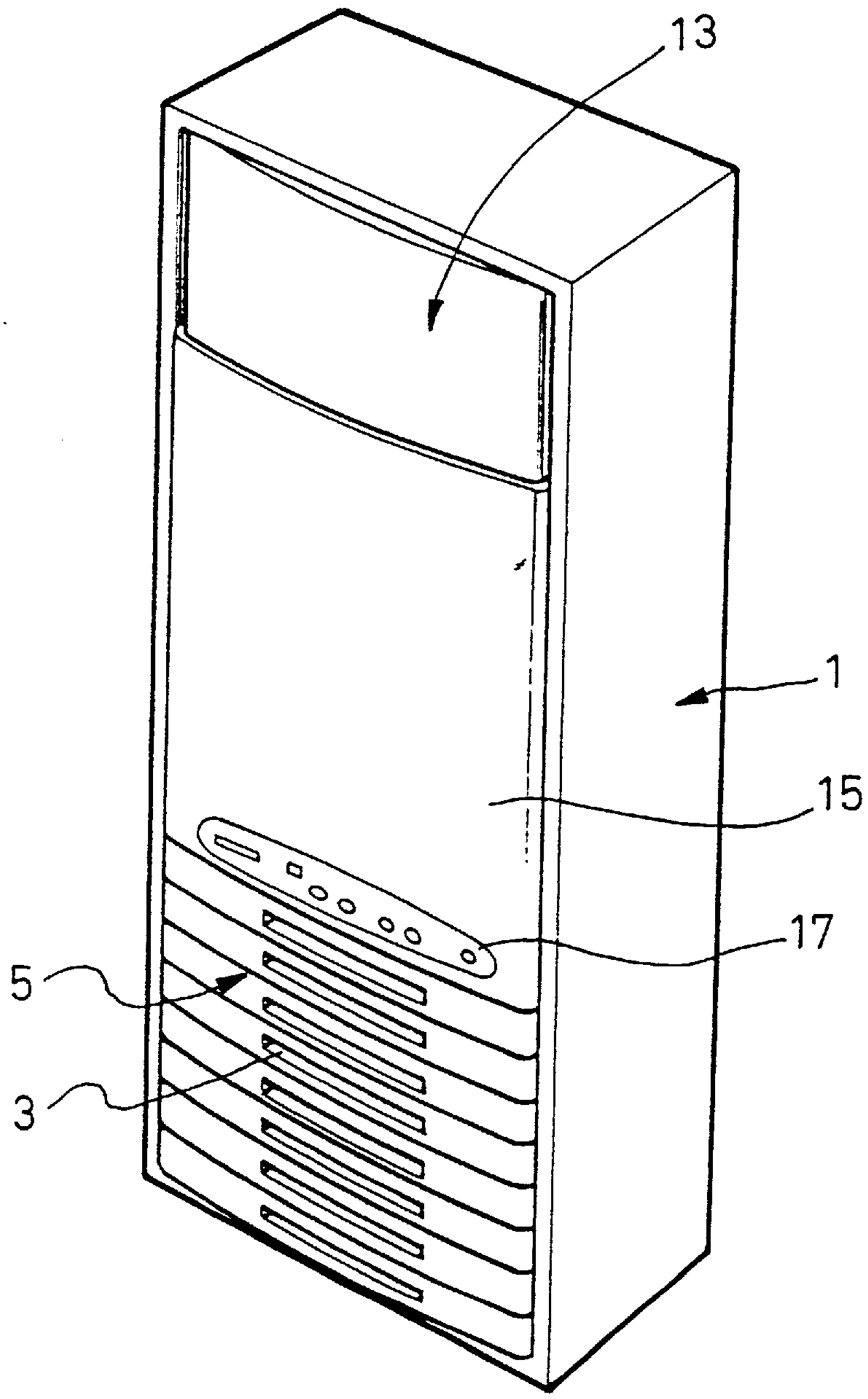


FIG.3

(PRIOR ART)

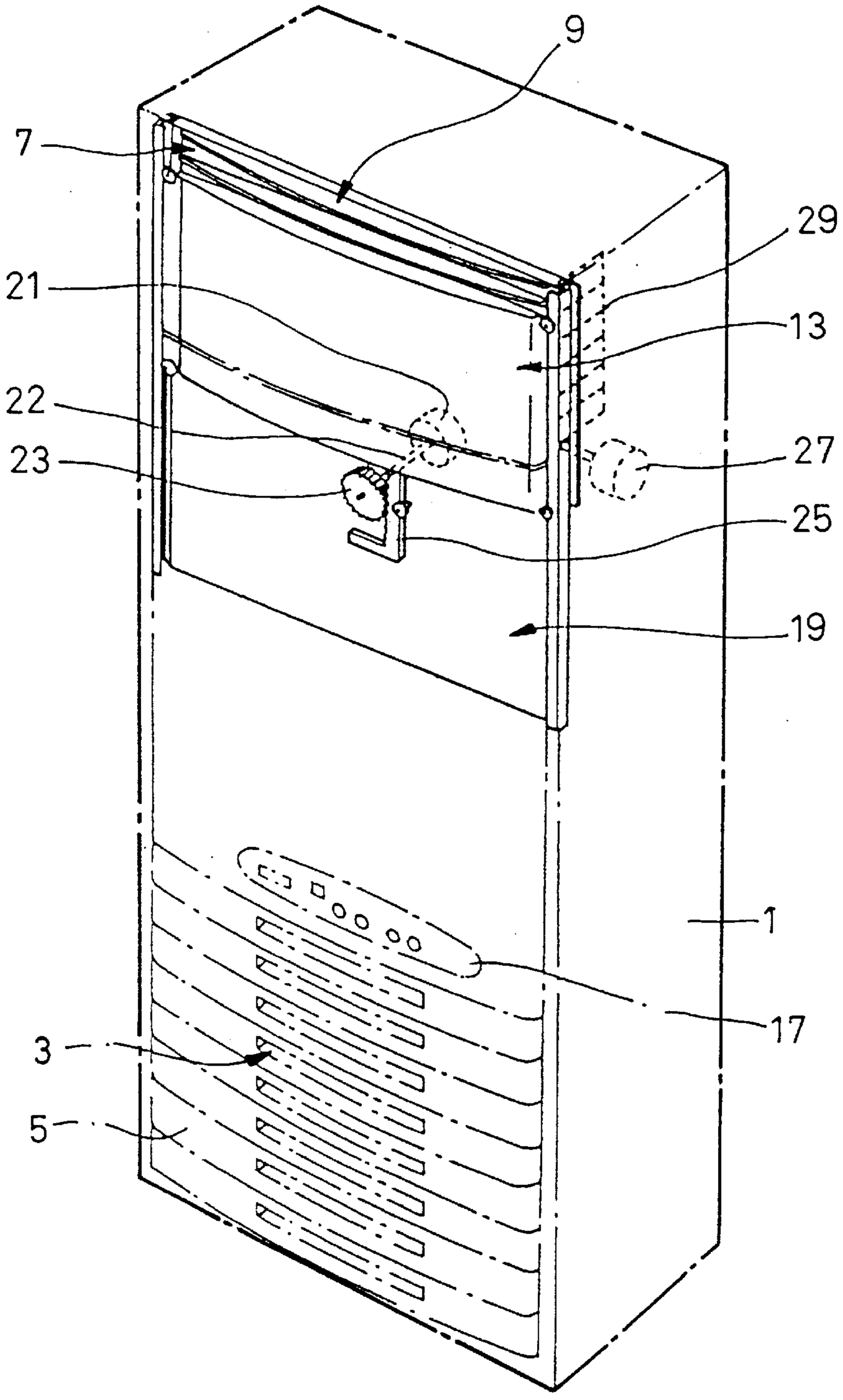


FIG.4

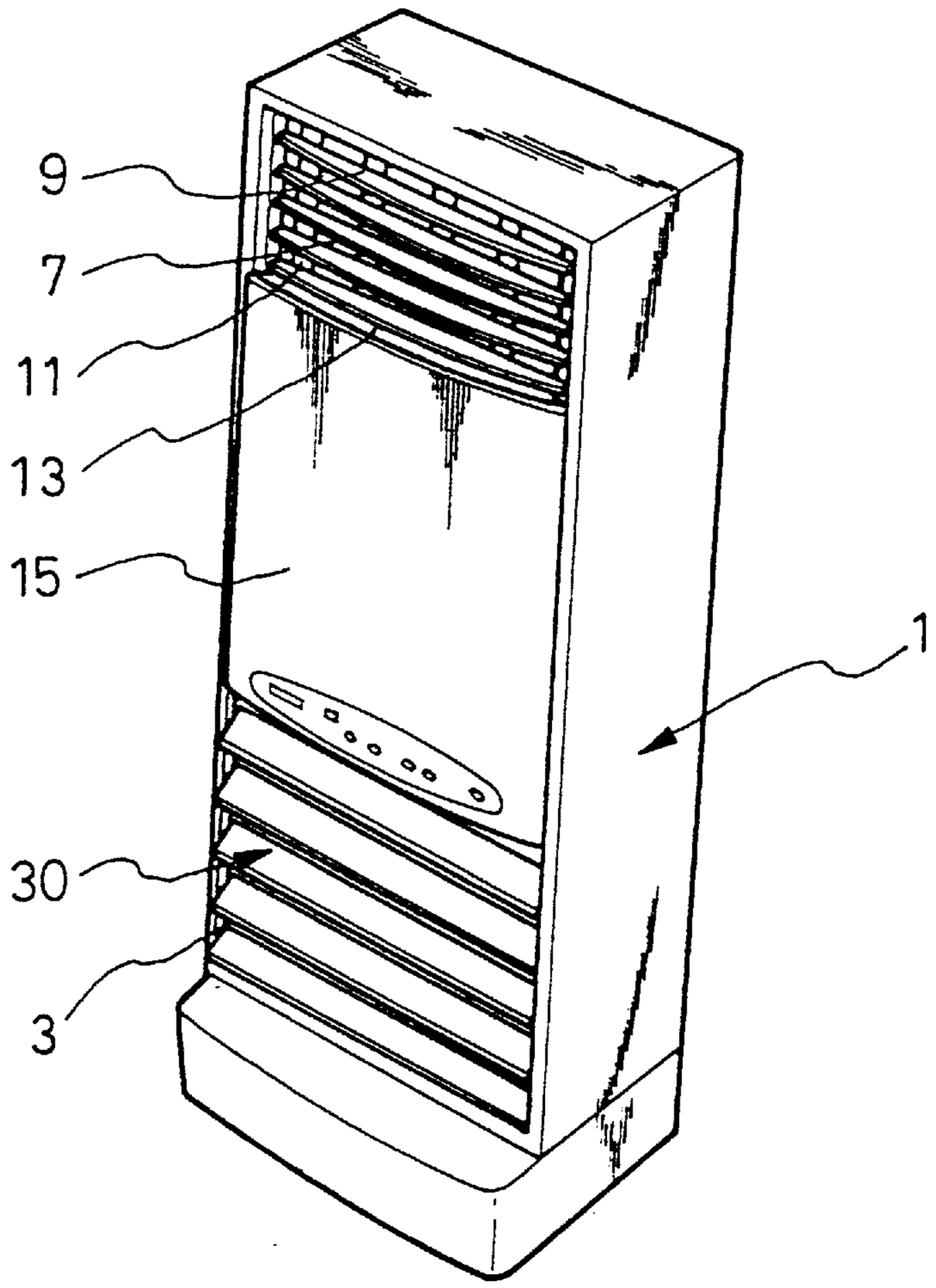


FIG.5

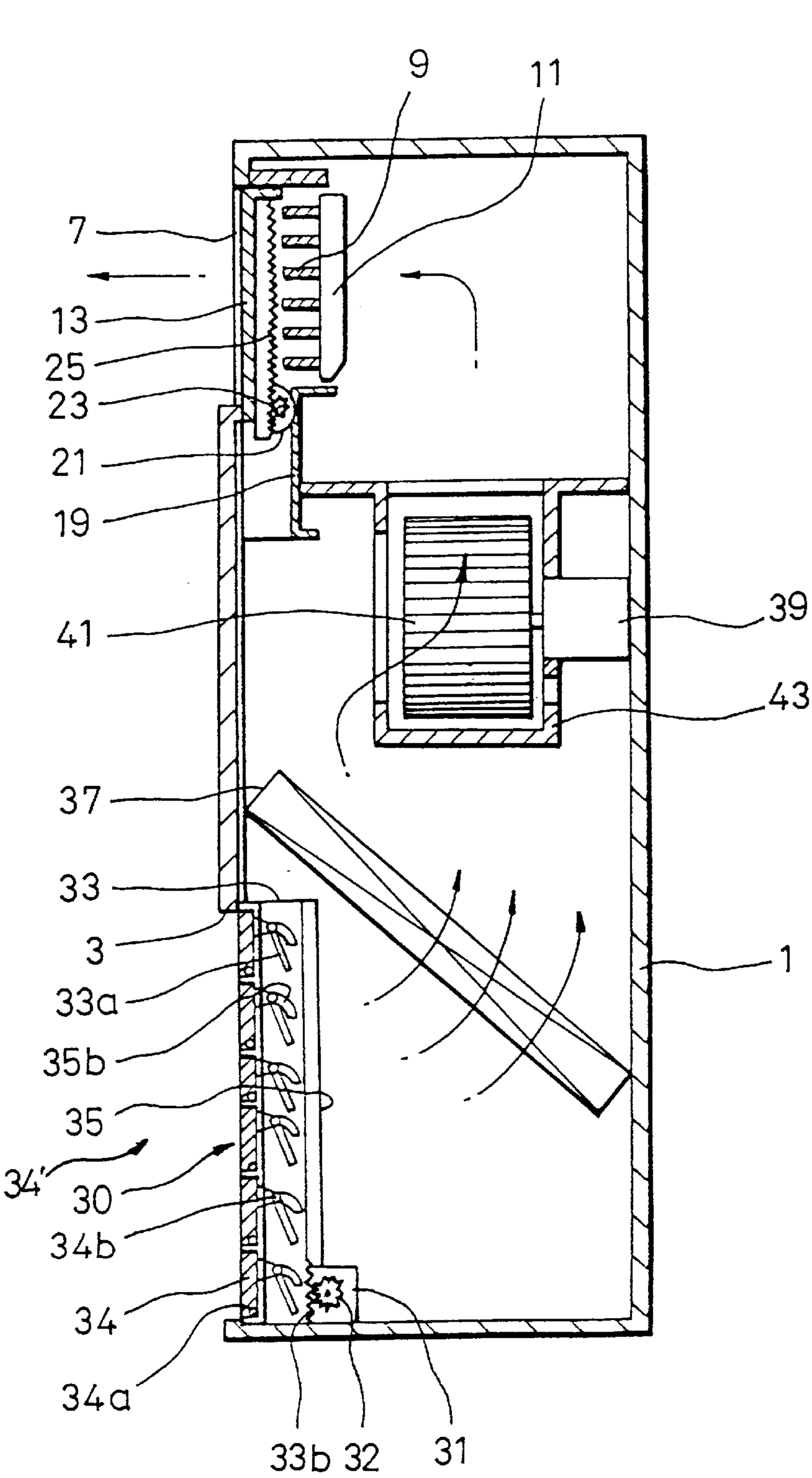

9
11
7
13
25
23
21
19
41
39
43
37
33
3
33a
35b
35
34'
30
34b
34
34a
1
33b
32
31

FIG.6

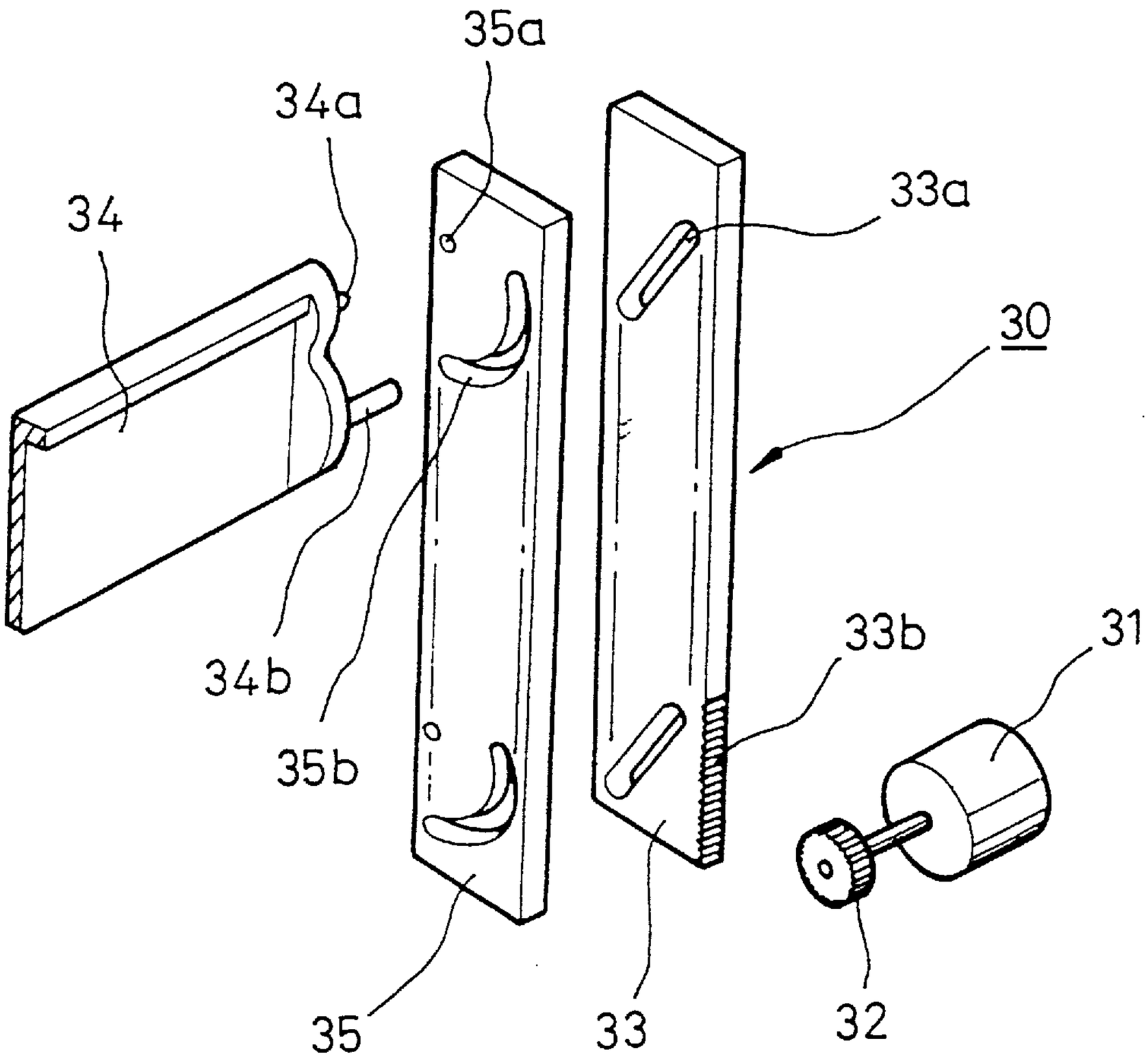


FIG.7

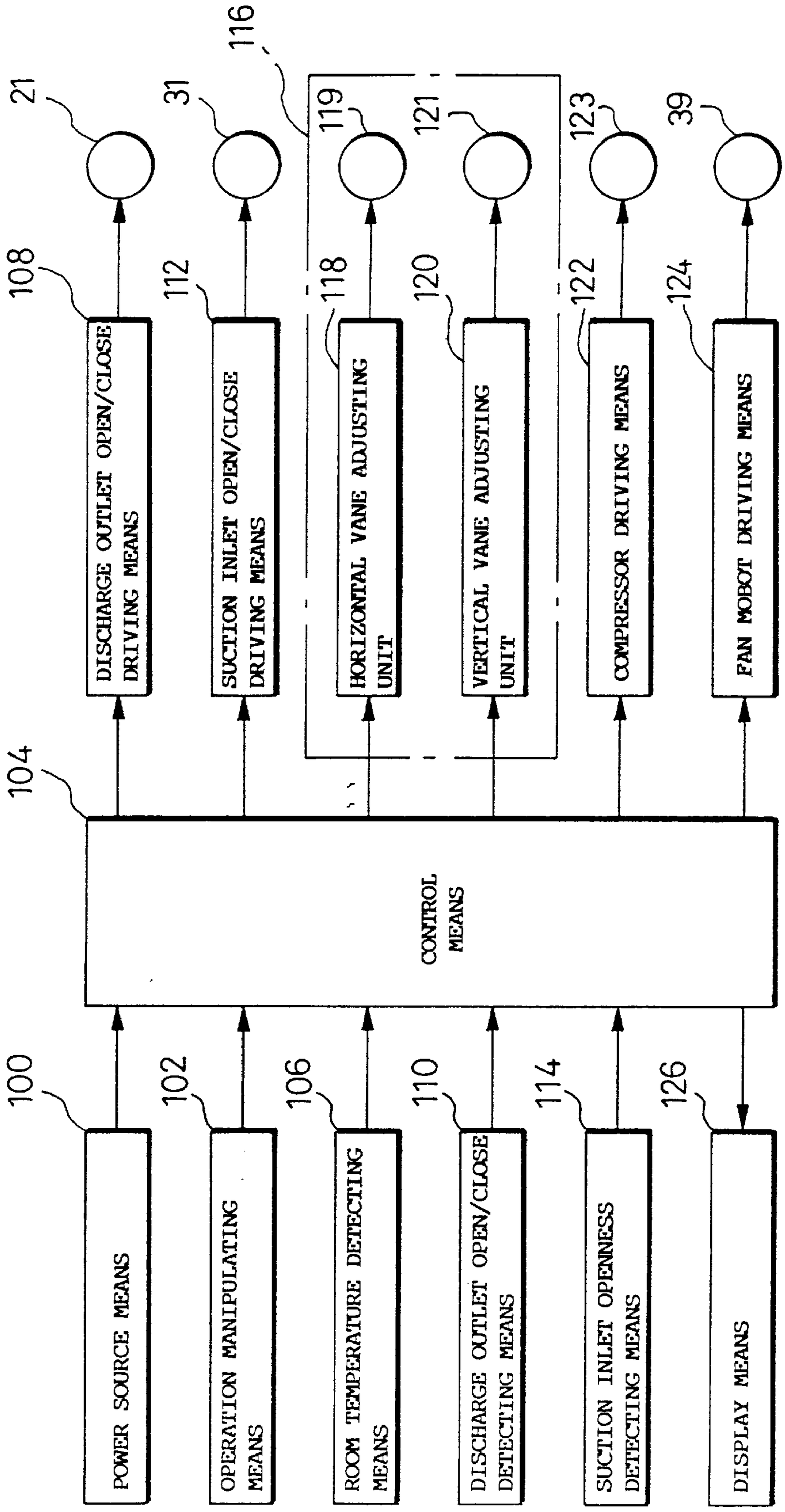

116
21
31
119
121
123
39
108
112
118
120
122
124
104
CONTROL MEANS
100
102
106
110
114
126
POWER SOURCE MEANS
OPERATION MANIPULATING MEANS
ROOM TEMPERATURE DETECTING MEANS
DISCHARGE OUTLET OPEN/CLOSE DETECTING MEANS
SUCTION INLET OPENNESS DETECTING MEANS
DISPLAY MEANS
DISCHARGE OUTLET OPEN/CLOSE DRIVING MEANS
SUCTION INLET OPEN/CLOSE DRIVING MEANS
HORIZONTAL VANE ADJUSTING UNIT
VERTICAL VANE ADJUSTING UNIT
COMPRESSOR DRIVING MEANS
FAN MOBOT DRIVING MEANS

FIG.8

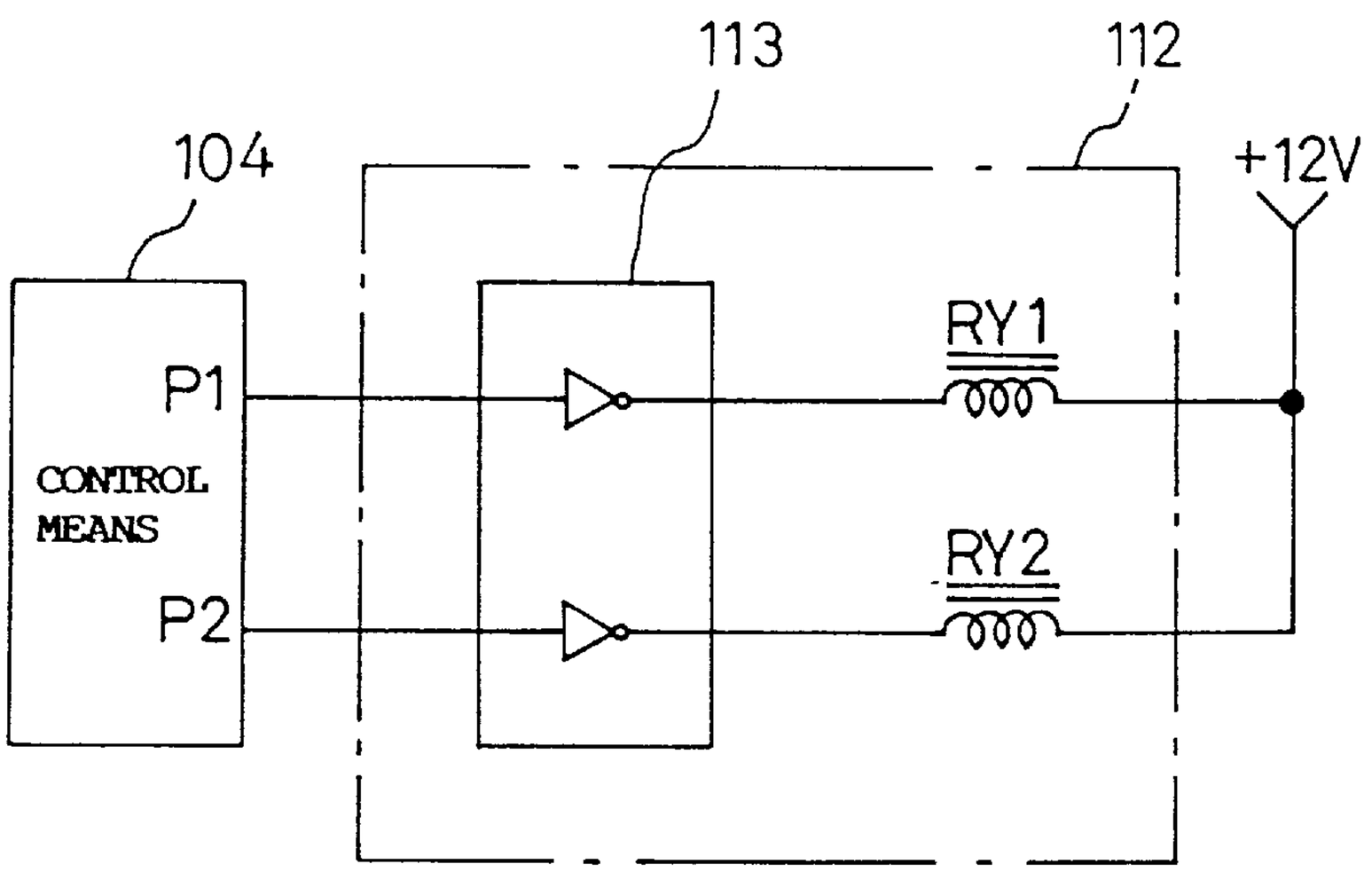

113
112
104
+12V
RY1
P1
CONTROL
MEANS
RY2
P2

FIG.8A

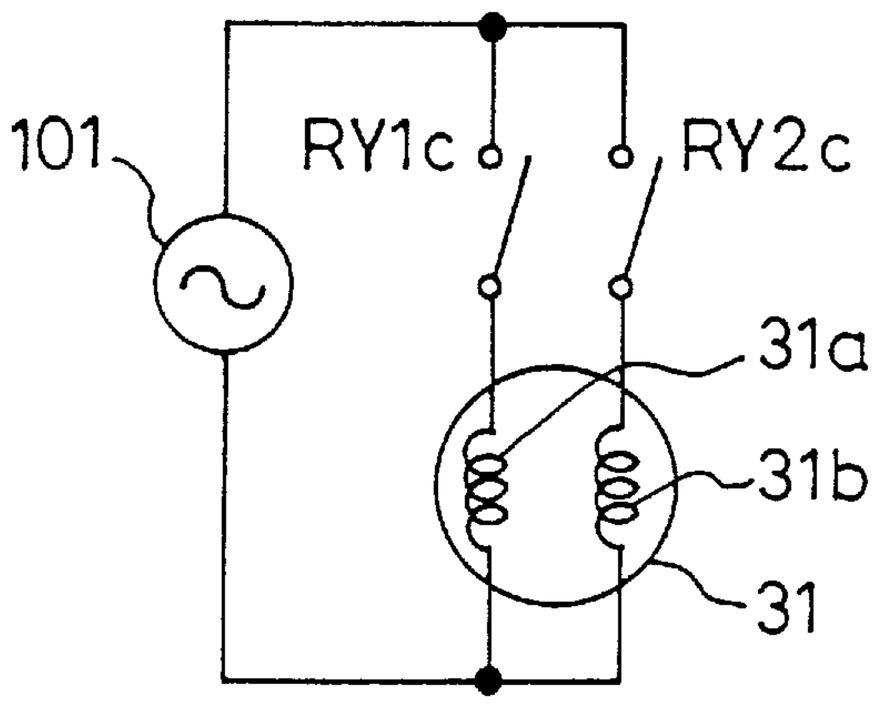

101
RY1c
RY2c
31a
31b
31

FIG.9A

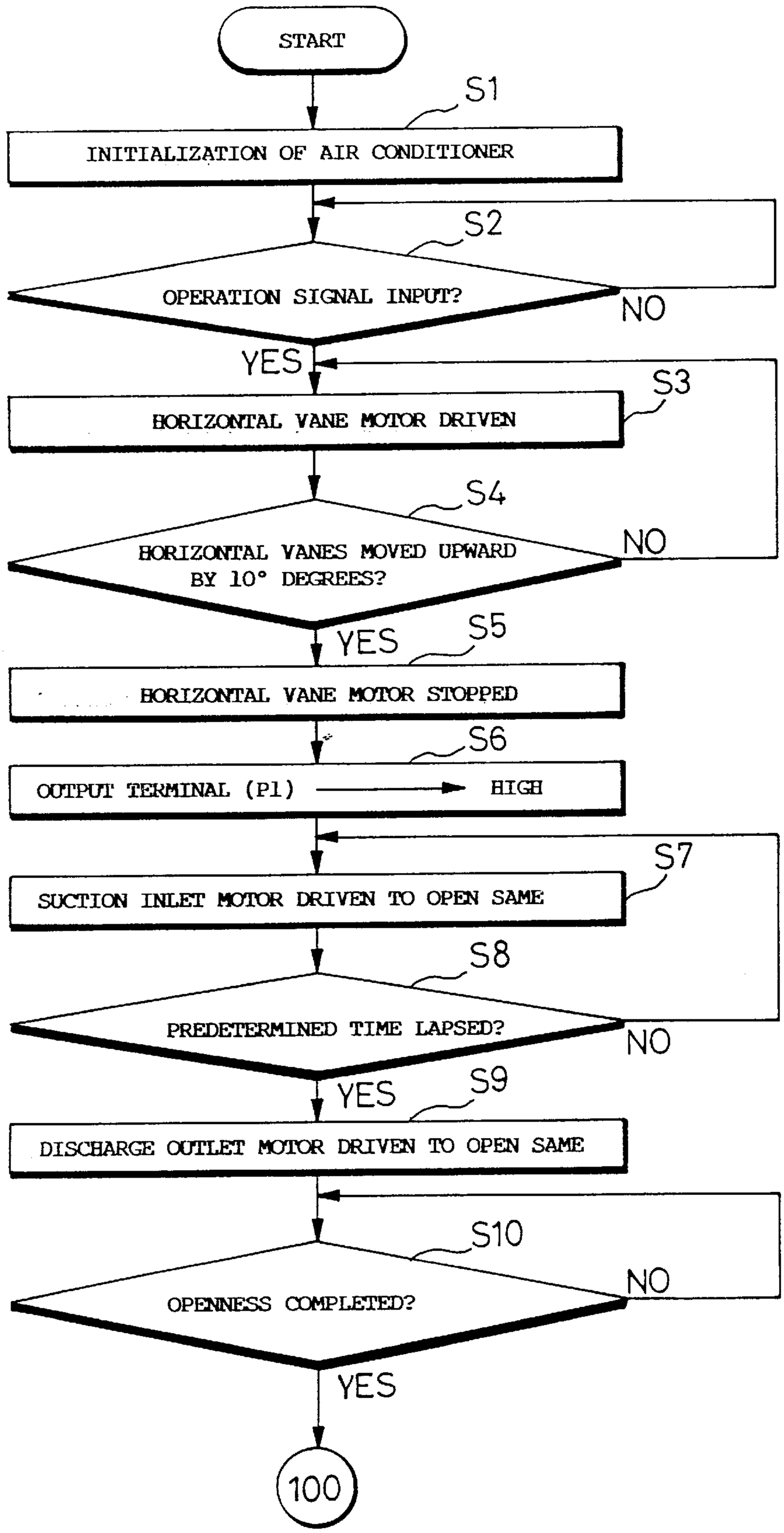

START
S1
INITIALIZATION OF AIR CONDITIONER
S2
OPERATION SIGNAL INPUT?
NO
YES
S3
HORIZONTAL VANE MOTOR DRIVEN
S4
HORIZONTAL VANES MOVED UPWARD BY 10° DEGREES?
NO
YES
S5
HORIZONTAL VANE MOTOR STOPPED
S6
OUTPUT TERMINAL (P1) HIGH
S7
SUCTION INLET MOTOR DRIVEN TO OPEN SAME
S8
PREDETERMINED TIME LAPSED?
NO
YES
S9
DISCHARGE OUTLET MOTOR DRIVEN TO OPEN SAME
S10
OPENNESS COMPLETED?
NO
YES
100

FIG.9B

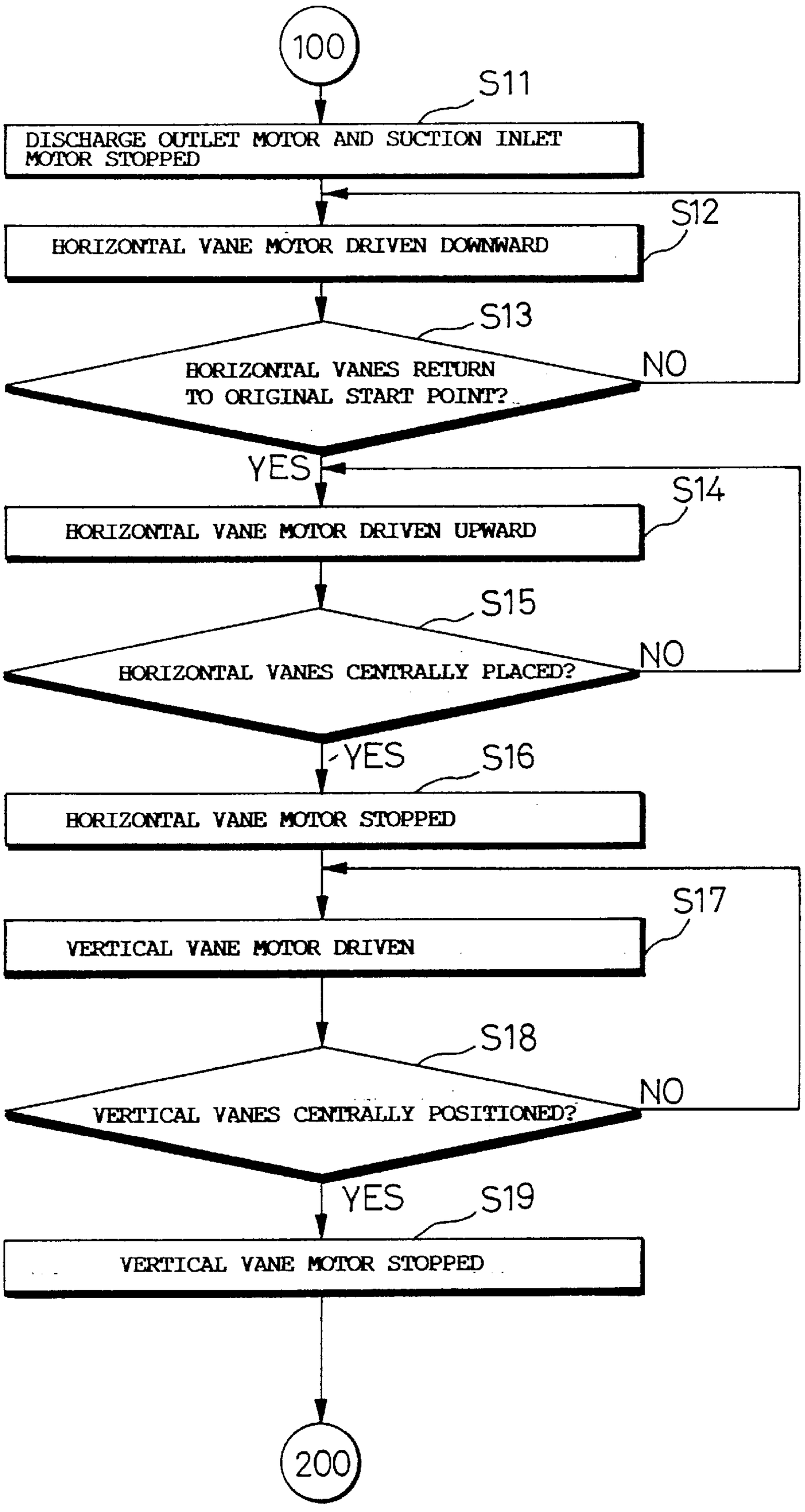

100
S11
DISCHARGE OUTLET MOTOR AND SUCTION INLET MOTOR STOPPED
S12
HORIZONTAL VANE MOTOR DRIVEN DOWNWARD
S13
HORIZONTAL VANES RETURN TO ORIGINAL START POINT?
NO
YES
S14
HORIZONTAL VANE MOTOR DRIVEN UPWARD
S15
HORIZONTAL VANES CENTRALLY PLACED?
NO
YES
S16
HORIZONTAL VANE MOTOR STOPPED
S17
VERTICAL VANE MOTOR DRIVEN
S18
VERTICAL VANES CENTRALLY POSITIONED?
NO
YES
S19
VERTICAL VANE MOTOR STOPPED
200

FIG.9c

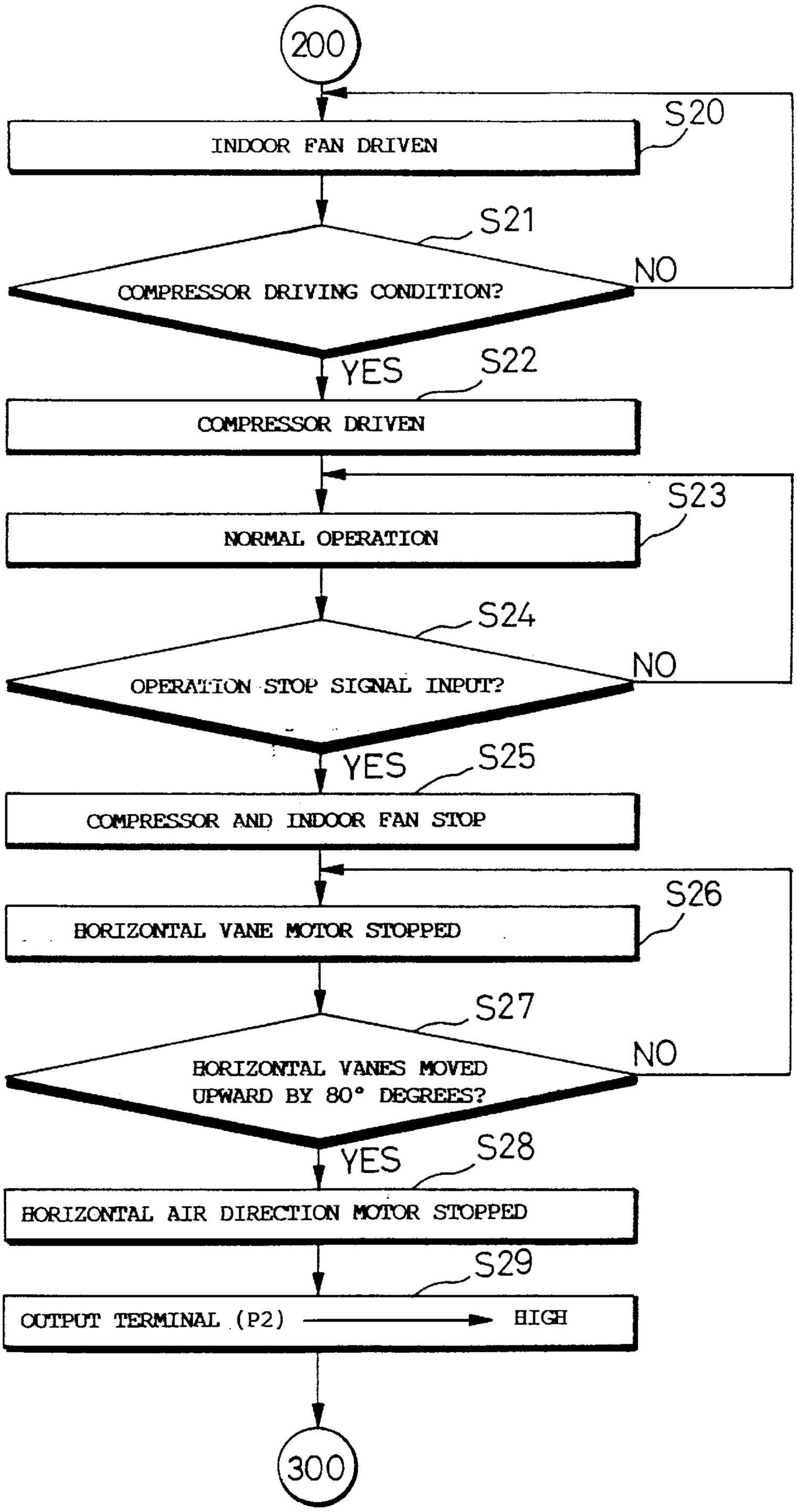
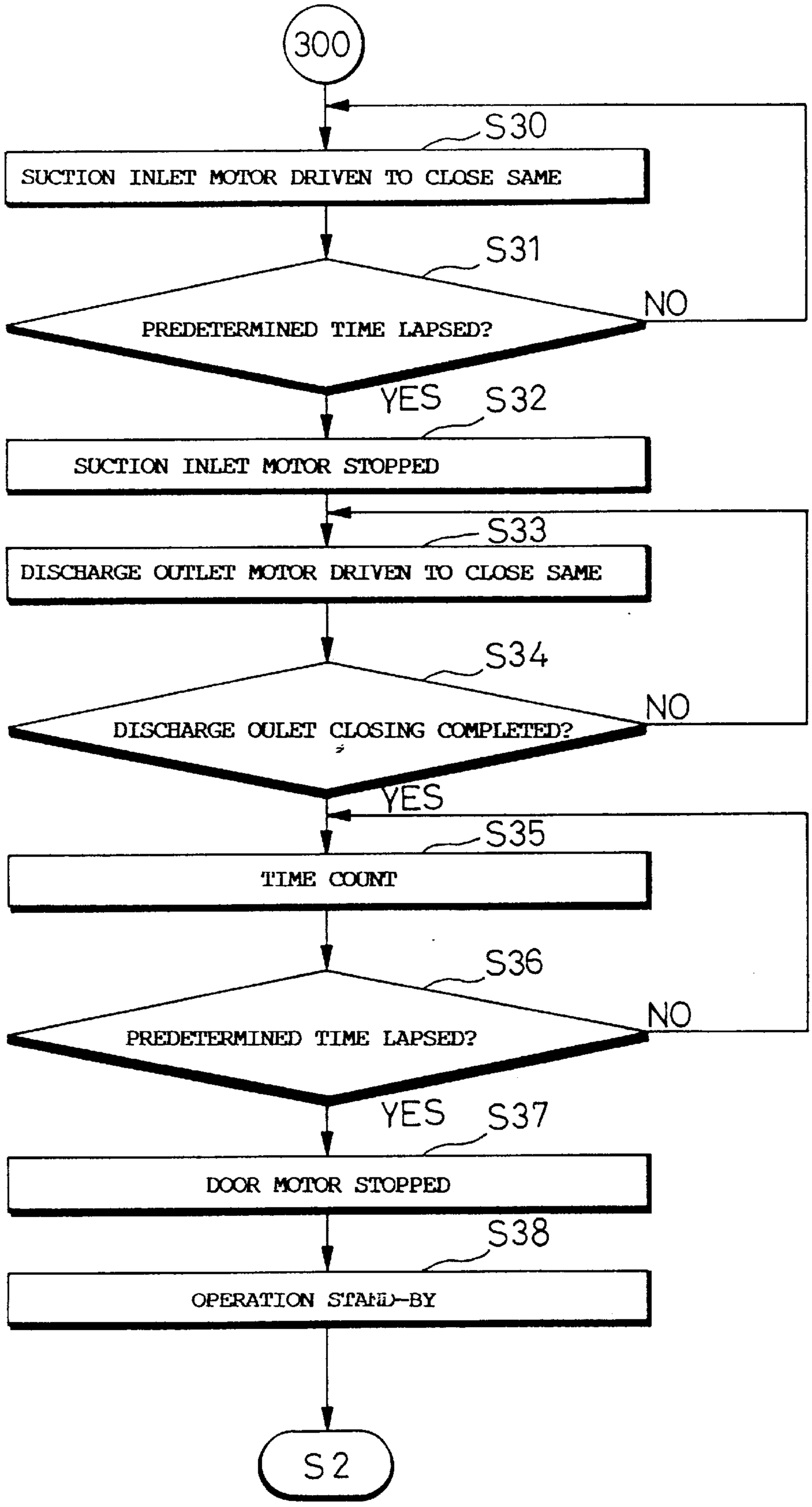

200
S20
INDOOR FAN DRIVEN
S21
COMPRESSOR DRIVING CONDITION?
NO
YES
S22
COMPRESSOR DRIVEN
S23
NORMAL OPERATION
S24
OPERATION STOP SIGNAL INPUT?
NO
YES
S25
COMPRESSOR AND INDOOR FAN STOP
S26
HORIZONTAL VANE MOTOR STOPPED
S27
HORIZONTAL VANES MOVED UPWARD BY 80° DEGREES?
NO
YES
S28
HORIZONTAL AIR DIRECTION MOTOR STOPPED
S29
OUTPUT TERMINAL (P2)
HIGH
300

FIG.9D


300
S30
SUCTION INLET MOTOR DRIVEN TO CLOSE SAME
S31
PREDETERMINED TIME LAPSED?
NO
YES
S32
SUCTION INLET MOTOR STOPPED
S33
DISCHARGE OUTLET MOTOR DRIVEN TO CLOSE SAME
S34
DISCHARGE OULET CLOSING COMPLETED?
NO
YES
S35
TIME COUNT
S36
PREDETERMINED TIME LAPSED?
NO
YES
S37
DOOR MOTOR STOPPED
S38
OPERATION STAND-BY
S2

ROOM AIR CONDITIONER HAVING INLET AND OUTLET CLOSURES AND METHODS FOR THEIR OPERATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an air conditioner and methods of its operation.

2. Description of the Prior Art

An air conditioner according to the prior art includes, as illustrated in FIGS. **1** and **2**, a suction grille member **5** formed with a plurality of suction inlets **3** for sucking in room air and disposed at a lower portion of an indoor unit body **1** (hereinafter referred to as a body), and a discharge outlet **7** formed at an upper front surface of the body **1** for discharging indoors the air which is heated or cooled while passing through the air conditioner.

The discharge outlet **7** is provided with horizontal vanes **9** swingable about horizontal axes for vertically adjusting the direction of the air discharged indoors therethrough and vertical vanes **11** rotatable about vertical axes for horizontally adjusting the direction of the air.

The air conditioner is provided with a discharge outlet door **13** for preventing foreign objects from entering therethrough and for forming an external appearance thereof.

The body **1** includes a cover member **15** for forming an external appearance thereof and for protecting the various elements therein.

The cover member **15** is provided with a manipulating unit **17** for adjusting the amount and direction of the air discharged through the discharge outlet **7**, selecting the operating modes (automatic, cooling, heating, dehumidifying, blow and the like) and to start/stop the operation.

As illustrated in FIG. **3**, driving means for horizontally moving the discharge outlet door **13** is formed by a support member **19** fixed to an upper front area of the body **1**, a discharge outlet motor **21** fixed to the support member **19** to generate a power for vertically moving the discharge outlet door **13**, a pinion **23** coupled to an axis **22** of the discharge outlet motor **21**, and a rack for changing a rotary movement of the pinion **23** to a rectilinear movement.

Furthermore, driving means for moving the horizontal vanes **9** includes a louver motor **27** (by way of example, a stepping motor) disposed in the body **1** and a plurality of link members **29** for being cooperatively driven by the louver motor **27** to thereby rotate a plurality of horizontal vanes **9**.

In the air conditioner thus constructed, when a user selects an operation mode according to the manipulation of a remotely controlled unit or an operating unit **17** to thereby activate an operation/stop key (hereinafter referred to as operation key), the discharge outlet motor **21** is driven in a forward direction to rotate the rack **25** downward, so that the discharge outlet door **13** coupled to the rack **25** is moved downward to thereby open the discharge outlet **7**.

At this time, when it is determined by door open/close sensors attached at predetermined upper and lower positions of the discharge outlet **7** that the discharge outlet **7** is completely opened, the discharge outlet motor **21** is stopped, and an indoor fan (not shown) is rotated to cause the room air to be sucked into the body **1** through the suction inlet **3**.

The room air sucked through the suction inlet **3** passes through a heat exchanger (not shown) to thereafter be heat-exchanged by latent heat of refrigerant flowing in the heat exchanger.

The heat-exchanged air is guided upward to thereafter be discharged indoors via the discharge outlet **7**, which is then adjusted in its direction vertically or horizontally according to angles of the horizontal vanes **9** and vertical vanes **11** to perform an air conditioning in the room.

At this time, when an operation key associated with the horizontal vanes **9** is turned on at the operating unit **17**, the louver motor **27** is rendered operative and a plurality of link members are cooperatively driven to vertically swing the horizontal vanes **9**.

When the key is turned on again, the louver motor **27** is rendered inoperative and the horizontal vanes **9** is are stopped to thereby establish a vertical component of the direction of the air flow.

When the operating key is turned off under a normal operation of the air conditioner thus described, the discharge outlet motor **21** is driven in reverse, and the pinion **23** is driven to shift the rack **25** upward, so that the discharge outlet door **13** is moved upward to close the discharge outlet **7**.

When it is determined by the door open/close sensors that the discharge outlet **7** is completely closed, the discharge outlet motor **21** is stopped and the air conditioner enters a stand-by state until the operation key is turned on again.

However, there is a problem in the conventional air conditioner thus constructed, in that the suction inlet **3** is open at all times even when the air conditioner is not operated, to enable dust, foreign objects and the like to be induced into the body **1** and to accumulate on surfaces of the heat exchanger and to thereby decrease the performance thereof.

There is another problem in that the vertical vanes **9** are randomly positioned when the air conditioner is turned off to thereby cause an unsatisfactory open/close operation of the discharge outlet door **13** due to contact between the door and the horizontal vanes **9** possibly resulting in a destruction of elements or an erroneous operation thereof.

There is still another problem in that upward travel extent of the discharge outlet door **13** may be limited due to a deformation of parts when a heavy load or the like is placed on an upper area of the body **1** to thereby press the upper area thereof downwardly. As a result, the discharge outlet door **13** may not be pushed far enough to enable the door open/close sensors to detect open/close operations of the discharge outlet door **13**, thereby resulting in an error.

SUMMARY OF THE INVENTION

The present invention is disclosed to solve the aforementioned problems and it is an object of the present invention to provide an open/close control apparatus of an air conditioner and a method thereof by which the suction inlet and a discharge outlet reach their fully open states simultaneously to thereby perform a pleasing operation of the air conditioner.

It is another object of the present invention to provide an open/close control apparatus of an air conditioner and a method thereof by which vanes are swung upward (e.g., by 10 degrees) when the discharge outlet is to be opened (lowered) to thereby enable a smooth opening operation of the discharge outlet door to take place.

It is still another object of the present invention to provide an open/close control apparatus of an air conditioner and a method thereof by which vanes are swung upward (e.g., by 80 degrees) when the discharge outlet is to be closed to thereby enable a smooth closing operation of the discharge outlet door to take place.

It is a further object of the present invention to provide an open/close control apparatus of an air conditioner and a method thereof by which a closing apparatus of the discharge outlet is placed in a completely closed position to thereby close the discharge outlet door accurately even when there occurs a mechanical problem at an upper end thereof.

It is still a further object of the present invention to provide an open/close control apparatus of an air conditioner and a method thereof by which vanes are positioned at a center, horizontal position when the discharge outlet is completely opened to effectively direct the flow of discharged air.

These and other objects are achieved by the present invention which relates to a method of operating a room air conditioner which includes a housing forming an air inlet for receiving incoming room, and an outlet for discharging the air back into the room. Vanes extend across the outlet and are mounted for swinging movement to adjust a flow direction of discharged air. A motor-actuated vane drive arrangement is provided for swinging the outlet vanes. A heat exchanger is disposed between the air inlet and air outlet for changing the temperature of air passing therethrough. An air circulator (e.g. a fan) is provided for circulating air into the inlet, through the heat exchanger, and out through the outlet. Inlet and outlet closures are provided for closing the inlet and outlet, respectively. A motor-driven first mechanism is provided for moving the inlet closure between and open and closed states. A motor-driven second mechanism is provided for moving the outlet closure between open and closed states. An input mechanism is provided for inputting operation instructions, including operation start and stop instructions. The method comprises the steps of:

A. actuating the vane drive arrangement for moving the outlet vanes to a clearance position facilitating an opening of the outlet closure in response to an operation start instruction being input to the input mechanism; thereafter

B. actuating the first and second mechanisms for opening the inlet and outlet closures respectively; thereafter

C. swinging the vanes to a position for discharging air in a generally forward horizontal direction; and thereafter

D. actuating the circulator and heat exchanger for performing an air conditioning operation.

It is also preferable to provide the following steps:

E. actuating the vane drive arrangement for moving the vanes to a clearance position facilitating closing of the outlet closure, in response to an operation stop instruction being input to the input mechanism; and thereafter

F. actuating the first and second mechanisms for closing the inlet and outlet closures, respectively.

Another aspect of the invention involves the use of a detector for sensing a position of the outlet closure at a time before the outlet closure reaches a fully closed state during a closing operation. The closing step would be continued for a predetermined time period following the detection of the outlet closure, to ensure that the outlet closure becomes fully closed.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be made to the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is a perspective view of a conventional air conditioner when a discharge outlet is open;

FIG. **2** is a perspective view of the conventional air conditioner when the discharge outlet is closed;

FIG. **3** is a schematic block diagram for illustrating a construction of the conventional air conditioner;

FIG. **4** is a perspective view for illustrating an air conditioner according to the present invention with the discharge outlet open;

FIG. **5** is a longitudinal sectional view for illustrating the air conditioner according to the present invention when a discharge outlet and a suction inlet are closed;

FIG. **6** is a perspective exploded view for illustrating principal elements according to the present invention;

FIG. **7** is a control block diagram of an open/close control apparatus of an air conditioner according to the present invention;

FIG. **8** is a detailed circuit diagram of suction inlet open/close driving means according to the present invention;

FIG. **8A** is a circuit diagram of a section of a controller depicted in FIG. **8**, for actuating an inlet vane actuating motor; and

FIGS. **9A** through **9D** are flow charts for illustrating an open/close control operational process of an air conditioner according to the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Throughout the drawings, like reference numerals and symbols as in FIGS. **1** to **3** are used for designation of like or equivalent parts or portions for simplicity of illustration and explanation, and redundant references will be omitted.

As illustrated in FIG. **4**, the suction inlet **3** formed at a lower portion of the body **1** is provided with suction inlet closure **30** for opening the suction inlet **3** when the air conditioner is operative and for closing the inlet **3** to prevent the infusion of dust, foreign objects and the like when the air conditioner is not operative, and to form a pleasing external appearance of the air conditioner. A closure **13** in the form of a door is vertically movable to open and close the outlet **7**.

As illustrated in FIG. **5**, the suction inlet closure **30** includes a pinion **32** for receiving an electric power of a suction inlet motor **31** to be rotated in forward and reverse directions, a slide member **33** engaging one side of the pinion **32** to be vertically moved in a linear direction according to the forward/reverse rotation of the pinion **32**, a suction grille **34'** formed by plurality of vanes **34** rotated by the linear movement of the slide member **33** to open and close the suction inlet **3**, and guide members **35** disposed at both sides of the vanes **34** to enable the vanes **34** to be rotatatively supported and guided.

The suction inlet closure **30** is disposed upstream of a bar-shaped heat exchanger **37**, and a fan **41** (hereinafter referred to as an indoor fan) is disposed above the heat exchanger **37**.

The indoor fan **41** is encased within a duct member **43** which covers the fan **41** and for guiding the flow of the air toward the discharge outlet **7**.

As illustrated in FIG. **6**, each end of each of the vanes **34** is provided with a hinge axle **34***a* for rotatatively supporting the vanes, and one end of each vane **34** is provided with a protruder **34***b* extending into a slot disposed in the slide member **33**.

Each of the guide member **35** is formed with fixed holes **35***a* in which respective hinge axles **34***a* are rotatably disposed.

One of the guide members **35** is formed with arch-shaped guide grooves **35***b* through which respective ones of the protruders **34***b* extend. The grooves are suitably oriented to open the vanes **34** when the slide member **33** is raised, and to close the vanes **34** when the side member **33** is lowered.

The slide member **33** is provided along one edge thereof with gear teeth **33***b* meshed with the pinion **32**.

Now, a circuit block diagram for controlling the open/close operation of the suction grille **34'** and the discharge outlet **13** in the air conditioner thus constructed will be described with reference to FIGS. **7**, **8** and **8**A.

As illustrated in FIGS. **7**, **8** and **8**A, power means **100** serves to change a commercial AC voltage supplied from an AC power terminal **100** to a predetermined DC voltage necessary for operation of the air conditioner to thereafter output same.

Operation manipulating means **102** contains a plurality of functional keys for selecting operation modes of the air conditioner (automatic, cooling, heating, dehumidifying, blowing and the like), air flow amount (strong wind, weak wind, intermediate wind and the like) discharged through the discharge outlet **7**, desired air temperature Ts (hereinafter referred to as established temperature), and an operation/stop key (hereinafter referred to as an operation key) for inputting an operation start signal and an operation stop signal to the air conditioner.

Control means **104** is a microcomputer adapted to receive a DC voltage output from the power means **100** to initialize the air conditioner and to control all operations of the air conditioner according to an operation selecting signal input by the operation manipulating means **102**.

The control means **104** serves to control the electric power applied to the suction inlet motor **31** for opening and closing the discharge outlet motor **21** and the suction grille and for effecting an open/close operation of the suction grille **34** by counting a closing drive time of the suction inlet motor **31**.

Room temperature detecting means **106** is adapted to monitor a present room temperature Tr so that the temperature can become a temperature Ts established by the user according to the operation manipulating means **102**. The discharge outlet open/close driving means **108** receives a control signal emitted from the control means **104** to controllably drive the discharge outlet motor **21** so that the discharge outlet door **13** for opening and closing the discharge outlet **7** can be vertically shifted.

Furthermore, discharge outlet open/close detecting means **110** serves to detect whether the discharge outlet door **13** is opened or closed.

Suction inlet open/close driving means **112** receives a control signal generated from the control means **104** when the operation start signal and the stop signal are input by the operation manipulating means **102** to controllably drive the suction inlet motor **31**, wherein the means **112** includes an inverter IC **113** for inverting a high-level open control signal and a high-level close control signal generated from output terminals P1 and P2 of the control means **104**, a relay RY I for driving with a DC voltage (12V) output from the power means **100** so that the suction inlet motor **31** can be driven in forward direction when a low-level open control signal inverted by the inverter IC **113** is output, and another relay RY2 for driving with the DC voltage output from the power means **100** so that the suction inlet motor **31** can be driven in reverse direction when a low-level close control signal inverted by the inverter IC **113** is generated.

Suction inlet detecting means **114** serves to detect a position of the slide member **33** to determine whether the vanes **34** have opened the suction inlet **3**.

Air direction adjusting means **116** serves to adjust directions of the discharged air horizontally and vertically so that the air can be evenly dispersed to the entire area of the room, where the means **116** includes an adjusting unit **118** for receiving a control signal output from the control unit **104** to drive a motor **119** so that the horizontal vanes **9** can be vertically moved, and an adjusting unit **120** for receiving a control signal generated from the control unit **104** to drive a motor **121** so that the vertical vanes **11** can be horizontally moved.

Compressor driving means **122** receives a control signal output from the control unit **104** according to a difference between the temperature Ts established by the user at the operation manipulating means **102** and a room temperature Tr detected by the room temperature detecting means **106** to thereby controllably drive a compressor **123**.

Fan motor driving means **124** receives a control signal emitted from the control unit **104** to control the speed of indoor unit fan motor **39** to drive indoor fan **41** so that the air heat-exchanged by the heat exchanger **37** can be blown indoors.

Furthermore, display means **126** displays operation selection modes (automatic, cooling, dehumidifying, blowing, heating and the like) input by the operation manipulating means **102** according to control of the control means **104**, established temperature Ts and room temperature Tr, and displays an operation state of the air conditioner as well.

Now, the operation of the open/close control apparatus will be described.

FIGS. **9**A through **9**D are flow charts for illustrating open/close control operating procedures of an air conditioner according to the present invention and reference symbol S in the drawings refers to method steps.

It is presumed that the suction inlet **3** and the discharge outlet **7** are closed as an initial condition for describing the operational procedures.

First of all, when a power is applied to the air conditioner, the power source means **100** serves to convert the commercial AC voltage supplied from the AC power terminal **101** to a predetermined DC voltage necessary for driving the air conditioner and thereafter outputs same to respective driving circuits and to control means **104**.

At step **S1**, the DC voltage output from the power source means **100** is received by the control means **104** to thereby initialize the air conditioner.

At this time, when the operation modes (automatic, cooling, dehumidifying, blowing, heating and the like) desired by the user according to the manipulation of the operation manipulating means **102** and the established temperature Ts are input and operation key is pressed, an operation selection signal and an operation start signal (hereinafter referred to as an operation signal) are input to the control means **104** from the operation manipulating means **102**.

Successively, at step **S2**, control means discriminates whether an operation signal is input from the operation manipulating means **102**, and if no operation signal is input (in case of NO), repeated operations subsequent to step **S2** are performed with the air conditioner being maintained at an operation stand-by state.

As a result of the discrimination at step **S2**, if the operation signal is input (in case of YES), flow advances to step **S3**, where the control means **104** outputs a driving pulse to the adjusting unit **118** for swinging the horizontal air direction vanes **9** upward (e.g., by 10 degrees) to a clearance

position so that the discharge outlet door **13** can be smoothly opened without being obstructed by the vanes **9**.

The adjusting unit **118** receives the driving pulse output from the control means to drive the motor **119**, which in turn causes a plurality of link members to cooperatively be operated and to simultaneously swing the horizontal vanes **9** upward.

At step **S4**, a counter of the control means **104** counts the number of pulses output during the drive of the motor **119** and compares that number with a reference value to determine whether the vanes **9** have moved 10 degrees upward.

As a result of the discrimination at step **S4**, if the vanes **9** are not swung 10 degrees upward (in case of NO), flow returns to step **S3**, where the control means **104** generates driving pulses to the adjusting unit **118** until the vanes **9** are moved 10 degrees upward and repeats operations subsequent to step **S3**.

As a result of the discrimination at step **S4**, if the vanes have moved 10 degrees upward (in case of YES), flow proceeds to step **S5**, where the adjusting unit **118** receives the driving pulses output from the control unit **104** to stop the motor **119** and to thereby discontinue the upward moving operation of the vanes **9**.

Successively, at step **S6**, the control means **104** outputs a control signal of high level to the suction inlet open/close driving means **112** via an output terminal **P1** in order to open the suction inlet **3** which has been closed.

In that regard, the control signal of high level output from the output terminal PI of the control means **104** is inverted to a low level via the inverter IC **113**, and the relay RYI is driven by a DC voltage (12V) output from the power source **100** to thereby close a contact RY1C.

When the contact RY1C of the relay RYI is closed, an AC voltage is applied to a winding **31** a of the suction inlet motor **31** from the AC power source terminal **101**, step **S7**, to thereby drive the suction inlet motor **31** in a forward direction and to rotate the pinion **32** engaged with an axle of the suction inlet motor **31**.

The slide member **33** meshed with the pinion **32** is raised, and the slanted slots **33***a* are also raised.

The protruders **34***b* of the vanes **34** are rotated in response to the raising of the slots **33***a* and are guided within the grooves **35***b*.

Each vane **34** is rotated at a predetermined angle about its hinge axle **34***a* to open the suction inlet **3**.

At step **S8**, the control means **104** counts a driving time of the suction inlet motor **31** to determine whether a predetermined period of time (e.g., approximately 1 minute) has lapsed, and if the predetermined period of time has not lapsed (in case of NO), flow returns to step **S7** to continuously drive the suction inlet motor **31**.

As a result of the discrimination at step **S8**, if the predetermined period of time has lapsed (in case of YES), flow proceeds to step **S9**, where the control means **104** generates a control signal to the door motor driving means **108** in order to open the discharge outlet **7** which has been closed.

Successively, the door motor driving means **108** drives the discharge outlet motor **21** according to the control of the control means **104** to thereby drive the discharge outlet motor in the forward direction.

The pinion **23** coupled to the axle **22** of the discharge outlet motor **21** lowers the rack **25** and the discharge outlet door **13** coupled to the rack **25** to open the discharge outlet **7**.

A required period of time (e.g., approximately 11.5 seconds) for opening the suction grille **34'** is longer by approximately 1 second than the time period (approximately 10.5 seconds) required for opening the discharge outlet door **13**, so that, in accordance with the invention, a driving start point of the suction inlet motor **31** where the suction grille **34'** starts to open is set to be sooner by 1 second than the start point of the discharge outlet motor **21** where the discharge outlet door **13** starts to open, so as to prevent possible consumer complaints due to a continued travel of the suction grille **34'** even after the discharge outlet door **13** is opened. That is, the opening completion moments for the suction grille **34'** and the discharge outlet door **13** are made to be the same.

Successively at step **S10**, the position of the discharge outlet door **13** moved downward by the discharge outlet motor **21** is detected by the door open/close detecting means **110** and a raised position of the slide member **33** moved upward by the suction inlet motor **31** is detected by suction inlet openness detecting means **114**.

Now, the control means **104** receives a signal detected by the discharge outlet open/close detecting means **110** and the suction inlet openness detecting means **114** to determine whether the discharge outlet door **13** and the suction grille are opened, and if the door **13** and grille **34'** are not opened (in case of NO), flow proceeds to step **S10** to continuously drive the discharge outlet motor **21** and the suction inlet motor **31** until the door **13** and the grille **34'** are opened.

As a result of the discrimination at step **S10**, if the door **13** and the grille **34'** are opened (in case of YES), flow advances to step **S11**, where the discharge outlet open/close driving means **108** stops the discharge outlet motor **21** according to control of the control means **104** to terminate the opening operation of the discharge outlet door **13**.

Suction inlet open/close driving means **112** stops driving of the suction inlet motor **31** according to the control signal of low level output from the output terminal **P1** at the control means **104** to thereby terminate an opening operation of the suction grille **34'**.

When the discharge outlet door **13** and the suction grille **34'** are completely opened, the control means **104**, at step **S12**, generates to the vertical air direction adjusting unit **114** a driving pulse for swinging the horizontal vanes **9** downward so that an operational original point for performing an accurate position control of the horizontal vanes **9** can be fixed.

Successively, the adjusting unit **114** receives a driving pulse output from the control means **104** to drive the motor **115**, such that the plurality of link members **29** are cooperatively activated to simultaneously move the horizontal vanes **9** downwards.

At step **S13**, the control means counts the number of pulses which are output during the drive of the motor **115** to thereby determine whether the horizontal vanes **9** have reached an original starting position thereof.

As a result of the discrimination at step **S13**, if the horizontal vanes **9** have not reached the original starting position thereof (in case of NO), flow returns to step **S12**, where the control means **104** outputs driving pulses to the adjusting unit **114** until the vanes **9** reach the original starting position thereof, and repeats operations subsequent to step **S12**.

Meanwhile, as a result of the discrimination at step **S13**, if the vanes **9** have reached the original starting point thereof (in case of YES), flow proceeds to step **S14**, where the control means **104** generates a driving pulse to the adjusting

unit **114** for moving the vanes **9** upward so that the vanes **9** can be positioned at a vertically central position, i.e. horizontally disposed, facing the front side of the air conditioner.

That is, the adjusting unit **114** receives the driving pulse from the control unit **104** to drive the motor **115** such that the plurality of link members **29** are cooperatively activated to upward swing the plurality of horizontal vanes **9** simultaneously.

At this time, at step **S15**, the control means **104** counts the number of pulses output when the horizontal air direction motor **115** is driven, thereby determining whether the vanes **9** have reached the center, horizontal position.

As a result of the discrimination at step **S15**, if the vanes **9** are not positioned in the center (in case of NO), flow returns to step **S14**, where the control means **104** outputs a driving pulse to the adjusting unit **114** until the vanes **9** reach the center position.

Meanwhile, as a result of the discrimination at step **S15**, if the vanes **9** have reached the center position (in case of YES), flow proceeds to step **S16**, where the adjusting unit **114** receives the driving pulse generated from the control means **104** to stop the motor **115**, thereby terminating the position control operation of the horizontal vanes **9**.

Successively, at step **S17**, the control means **104** emits a driving pulse to the horizontal air direction adjusting unit **120** to move the vertical vanes **11** to a center position.

The adjusting unit **120** receives the driving pulse emitted from the control means **104** to drive the motor **121** so that the plurality of vanes **11** are simultaneously moved to the center, i.e., the vanes are disposed in planes lying perpendicular to a plane of the air outlet.

At step **S18**, the control means **104** counts the number of pulses emitted from the motor **121** when it is activated and determines whether the vertical vanes **11** are disposed at the center.

As a result of the discrimination at step **S18**, if the vanes **11** are not positioned in the center (in case of NO), flow returns to step **S17**, where the control means **104** generates a driving pulse to the adjusting unit **120** until the vanes **11** are positioned in the center and repeats operations subsequent to step **S17**.

Meanwhile, as a result of the discrimination at step **S18**, if the vanes **11** are positioned in the center (in case of YES), flow advances to step **S19**, where the adjusting unit **120** receives the driving pulse emitted from the control means **104** to stop the motor **121** to finish a position control operation of the vanes **11**. Thus, the vanes **9**, **11** are now oriented to discharge the air in a forward direction perpendicular to a plane of the outlet.

Successively, at step **S20**, fan motor driving means **124** controls the speed of the indoor fan motor **39** according to control of the control means **104** to drive the indoor fan **41**.

When the indoor fan **41** is driven, the room air starts to be sucked into the body **1** through the suction inlet **3**, at which time, the temperature Tr of the room air sucked through the suction inlet **3** is detected by the room temperature detecting means **106**.

At step **S21**, a comparison is made between the room temperature Tr detected by the room temperature detecting means **106** and the temperature Ts established by the user via the operation manipulating means **102**, to thereby determine whether the compressor **123** should be driven.

A driving condition of the compressor **123** means that, in case of a cooling operation, the room temperature Tr detected by the room temperature detecting means **106** is larger than the temperature Ts established by the user, and, in case of a heating operation, the room temperature Tr detected by the room temperature detecting means **106** is smaller than the temperature Ts established by the user.

As a result of the discrimination at step **S21**, if the compressor **123** is not required to be driven (in case of NO), flow returns to step **S20**, whereby the room temperature Tr is continually detected, and operations subsequent to step **S20** are repeated. If the compressor **123** is required to be driven (in case of YES), flow advances to step **S22**, where the control means **104** determines an operation frequency of the compressor **123** as a function of the difference between the room temperature Tr and the established temperature Ts and emits to compressor driving means **122** a control signal for driving the compressor **123**.

The compressor driving means **122** then drives the compressor **123** at the operation frequency determined by the control means **104**.

When the compressor **123** is driven, the indoor fan **41** is driven at step **S23**, and the room air is sucked into the body **1** through the suction inlet **3**, and the room air sucked through the suction inlet **3** is heated or cooled by the heat exchanger **37**.

Upon leaving the heat exchanger **37**, the air is moved upward and discharged into the room in a direction determined by the direction angles of the horizontal vanes **9** and vertical vanes **11**.

In a normal operation of an air conditioner thus described, a discrimination is made at step **S24** as to whether an operation stop signal has been input via an operation key at the operation manipulating means **102**, and if the operation stop signal has not been input (in case of NO), flow returns to step **S23**, and the normal operation continues and operations subsequent to step **S23** are repeated.

As a result of the discrimination at step **S24**, if the operation stop signal has been input during the normal operation (in case of YES), flow proceeds to step **S25**, where the control signal **104** generates a control signal to the compressor driving means **122** and to fan motor driving means **124** in order to stop the compressor **123** and the indoor fan motor **39**.

Successively, the compressor driving means **122** stops the compressor **123** according to the control of the control means **104** and the fan motor driving means **124** stops the indoor fan motor **39** according to the control of the control means **104** to thereby stop driving the indoor fan **41**.

At step **S26**, the control means **104** generates a driving pulse to the adjusting unit **118** in order to move upward the horizontal vanes **9** so that a closing operation of the discharge outlet door **13** can be performed smoothly.

Successively, the adjusting unit **118** receives the driving pulse output from the control means **104** to drive the motor **119**, such that the plurality of link members **29** are cooperatively activated to simultaneously swing the plurality of horizontal vanes **9** upward, e.g., by 80 degrees, to a clearance position facilitating closing of the door **13**.

At this time, at step **S27**, the control means **104** counts the number of pulses output from when the motor **119** begins to be driven, so that a discrimination can be made as to whether the vanes **9** have moved 80 degrees upward. If the vanes **9** have not moved 80 degrees upward (in case of NO), flow returns to step **S26**, where the control means **104** supplies a driving pulse to the adjusting unit **118** until the vanes **9** are moved 80 degrees upward and repeats operations subsequent to step **S26**.

As a result of the discrimination at step S27, if the vanes **9** have been moved 80 degrees upward (in case of YES), flow proceeds to step S28, where the adjusting unit **118** receives the driving pulse output from the control means **104** to stop the motor **119**, thereby terminating the vertical movement operation of the vanes **9**.

Successively, at step S29, the control means **104** generates a control signal of high level to the suction inlet open/close driving means via the output terminal P2 in order to close the opened suction inlet **3**.

Then, the high level control signal output from the output terminal P2 at the control means **104** is inverted to a low level via the inverter IC **113**, and the relay RY2 is driven by DC voltage 12V output from the power source means **100** to thereby close a contact RY2C at the relay RY2.

When the contact RY2C of the relay RY2 is closed, an AC voltage is applied to a winding **31***b* of the suction inlet motor **31** from the AC power source terminal **101**, step S30, to thereby drive the suction inlet motor **31** in the reverse direction, which then reverses the rotation of the pinion **32** coupled to the axle of the suction inlet motor **31**.

The slide member **33** meshed with the pinion **32** is lowered to thereby lower the slide member **33** and the slots **33***a* thereof.

In response to a descent of the slots **33***a,* the protruders **34***b* are rotated about the axes of axles **34***a* while being guided by the grooves **35***b*. Thus, the vanes **34** of the suction grille **34** are rotated by a predetermined angle to close the suction inlet **3**.

At step S31, the control means **104** counts a driving time of the suction inlet motor **31** and discriminates if a predetermined time (approximately 11.5 seconds which is a time data needed for closing the suction grille, obtained through tests.) has lapsed, and if the predetermined time has not lapsed (in case of NO), flow returns to step S30, and the suction inlet motor **31** continues to be driven until the suction grille **34** is closed.

As a result of the discrimination at step S31, if the predetermined time has lapsed (in case of YES), flow proceeds to step S32, presuming that the suction grille **34** has been completely closed, where the suction inlet open/close driving means **110** stops the motor **31** according to a control signal of low level output from the output terminal P2 at the control means **104**, thereby terminating the closing operation of the suction grille **34**.

Successively, at step S33, the control means **104** generates a control signal to the discharge outlet open/close driving means **108** in order to close the discharge outlet which has been opened.

The discharge outlet open/close driving means **108** activates the discharge outlet motor **21** according to the control of the control means **104** to thereby drive the discharge outlet motor **21** in the reverse direction, where the pinion **23** coupled to the axle **22** of the discharge outlet motor **21** is driven to move the rack **25** upward, and the discharge outlet door **13** coupled to the rack **25** is moved upward to close the discharge outlet **7**.

At this time, at step S34, the position of the raised discharge outlet **13** is detected by the detecting means **110**, so the control means **104** receives a signal detected by the detecting means **110** to discriminate whether the discharge outlet **13** is closed.

As a result of the discrimination at step S34, if the discharge outlet **13** is not closed (in case of NO), flow returns to step S33, to keep driving the discharge outlet motor **21** until the discharge outlet **13** is completely closed.

In case of the discharge outlet door **13** having been closed (in case of YES), flow advances to step S35, where the control means **104** counts the time of the discharge outlet door **13** being closed.

It should be noted that, because the position of the sensor for detecting the closing operation of the discharge outlet door **13** is below a position where the discharge outlet door **13** is completely closed (i.e., the sensor is at a position whereby it is actuated approximately one second prior to a complete door closing), the discharge outlet motor **21** must be driven to move the discharge outlet door **13** upward to a fully closed state, even after the sensor detects the door. Therefore, the driving time of the discharge outlet motor **21** must be counted from the actuation of the sensor.

As a result of the discrimination at step S36, if the predetermined time has not lapsed (in case of NO), flow returns to step S35, and repeats operations subsequent thereto.

If, as a result of the discrimination at S36, the predetermined time has lapsed (in case of YES), it is presumed that the discharge outlet door **13** has moved upward to completely close the discharge outlet **7**, even if there is a mechanical deformation at an upper end of the discharge outlet **7**, so that, flow proceeds to step S37, where the discharge outlet open/close driving means **108** stops the motor **104** to terminate the closing operation of the discharge outlet door **13**.

Meanwhile, it should be noted that the driving of the suction inlet motor **31** in steps S30 to S32, occurs simultaneously with the driving of the discharge outlet motor **21** in steps S33 to S37; the steps **30–37** are listed in sequence in the drawing merely to simplify the explanation.

Successively, at step S38, the control means **104** maintains the air conditioner at a stand-by state until an operation signal is input again by the operation manipulating means **102**, and returns to step S2 to repeat operations subsequent to step S2.

As is apparent from the foregoing, advantages result from the open/close control apparatus of an air conditioner and method thereof according to the invention, such as: (a) the closures for the suction inlet **3** and the discharge outlet **7** reach their fully opened states simultaneously; (b) the vanes **9** are swung upwardly before the door **13** is swung upwardly or downwardly, to thereby enable the open/close operations of the discharge outlet door **13** to function smoothly, (c) the detection of the position of the discharge outlet door **13** during a closing operation occurs before the door reaches a fully closed state and is driven for a period thereafter, to enable an accurate closing of the discharge outlet door **13** even when there is a mechanical discrepancy at an upper area of the discharge outlet **7**, and (d) the vanes **9** and **11** are oriented in respective center positions when the discharge outlet **7** is completely opened, to thereby control the air directions of the discharged air effectively.

Although the present invention hag been described in connection with a preferred embodiment thereof, it will be appreciated by those skilled in the art that additions, deletions, modifications, and substitutions not specifically described may be made without departing from the spirit and scope of the invention as defamed in the appended claims.

What is claimed is:

1. A method of operating a room air conditioner which includes a housing forming an air inlet for receiving incoming room air, and an air outlet for discharging the air back into the room, a plurality of vanes extending across the outlet and being mounted for swinging movement to adjust

a flow direction of discharged air, a motor-actuated vane drive arrangement for swinging the outlet vanes, a heat exchanger disposed between the air inlet and air outlet for changing the temperature of air passing therethrough, an air circulator for circulating air into the inlet, through the heat exchanger and out through the outlet, an inlet closure for closing the inlet, an outlet closure for closing the outlet, a motor-driven first mechanism for moving the inlet closure between open and closed states, a motor-driven second mechanism for moving the outlet closure between open and closed states, and an input means for inputting operating instructions including operation start and stop instructions, the method comprising the steps of:

A) actuating the vane drive arrangement for moving the outlet vanes to a clearance position facilitating an opening of the outlet closure in response to an operation start instruction being input to the input means; thereafter

B) actuating the first and second mechanisms for opening the inlet and outlet closures, respectively; thereafter

C) swinging the vanes to a position for discharging air in a generally forward horizontal direction; and thereafter

D) actuating the circulator and heat exchanger for performing an air conditioning operation.

2. The method according to claim **1**, further comprising, subsequent to step D, the steps of:

E) actuating the vane drive arrangement for moving the vanes to a clearance position facilitating closing of the outlet closure, in response to an operations stop instruction being input to the input means; and thereafter

F) actuating the first and second mechanisms for closing the inlet and outlet closures, respectively.

3. The method according to claim **2** further including the step of detecting a position of the outlet closure during step F and continuing to perform step F for a predetermined time period following the detection step.

4. The method according to claim **1** wherein the inlet closure comprises a grille formed by swingable inlet vanes, a time period for fully opening the inlet closure being greater than a time period for fully opening the outlet closure, and step B comprises initiating actuation of the first mechanism prior to initiating actuation of the second mechanism to cause the inlet and outlet closures to reach their respective open states simultaneously.

5. The method according to claim **1** wherein step A comprises swinging the vanes upwardly by an angle greater than zero degrees and not greater than 30 degrees.

6. The method according to claim **1** wherein step E comprises swinging the vanes upwardly by an angle from 60 to 90 degrees.

7. A method of operating a room air conditioner which includes a housing forming an air inlet for receiving incoming room air, and an air outlet for discharging the air back into the room, a plurality of outlet vanes extending across the outlet and being mounted for swinging movement to be adjustable for varying a direction of flow of discharged air, a motor-actuated outlet vane drive mechanism for swinging the outlet vanes, a heat exchanger disposed between the air inlet and air outlet for changing the temperature of air passing therethrough, an air circulator for circulating air into the inlet, through the heat exchanger and out through the outlet, an inlet closure in the form of swingable inlet vanes for closing the inlet, an outlet closure for closing the outlet, a motor-driven first mechanism for moving the inlet closure between open and closed states, a motor-driven second mechanism for moving the outlet closure between open and closed states, a detector for sensing a position of the outlet closure, an input means for inputting operating instructions including operation start and stop instructions, and a controller connected to the input means and the first and second mechanisms for controlling operation of the first and second mechanisms, the method comprising the steps of:

A) actuating the vane drive arrangement for swinging the outlet vanes to a clearance position away from a path of travel of the outlet closure, in response to an operation start instruction being input to the input means; thereafter

B) actuating the first and second mechanisms for moving the inlet and outlet closures to their respective open states;

C) receiving a signal from the detector during step B for indicating a position of the outlet closure;

D) swinging the outlet vanes from the clearance position to an air discharge position for directing air during operation of the air conditioner;

E) actuating the vane drive arrangement for moving the outlet vanes to a clearance position away from a path of travel of the outlet closure, in response to an operation start instruction being input to the input means; thereafter

F) actuating the first and second mechanisms for moving the inlet and outlet closures to their respective closed states; and

G) receiving a signal from the detector during step F for detecting a position of the outlet closure.

8. The method according to claim **7**, wherein the respective time periods for fully opening the inlet and outlet closures are different, and further comprising the step of synchronizing operations of the first and second mechanisms for causing the inlet and outlet closures to reach their respective closed states simultaneously.

9. The method according to claim **7** wherein the controller counts pulses during steps A and E for determining whether the outlet vanes have reached a final position away from the path of travel of the outlet closure.

10. The method according to claim **7** wherein step F comprises actuating the second mechanism for a predetermined time period following step G to ensure that the outlet closure reaches its closed state.

11. The method according to claim **10** wherein the predetermined time period is 1 to 3 seconds.

12. The method according to claim **7** wherein step A comprises swinging the outlet vanes upwardly to a predetermined orientation, and step B comprises moving the outlet closure downwardly.

13. The method according to claim **12** wherein step A comprises swinging the outlet vanes upwardly by an angle greater than zero and not greater than ninety degrees.

14. The method according to claim **12** wherein step A comprises swinging the outlet vanes upwardly by an angle greater than zero and not greater than thirty degrees.

15. The method according to claim **7** wherein step E comprises swinging the outlet vanes upwardly to a predetermined orientation, and step F comprises moving the outlet closure upwardly.

16. The method according to claim **15** wherein step E comprises swinging the outlet vanes upwardly by an angle in range of 60–90 degrees.

17. The method according to claim **7** wherein each of steps B and F comprises causing the inlet and outlet closures to reach their open and closed states simultaneously.

18. The method according to claim **17** wherein each of claims B and F comprises initiating actuation of one of the

first and second mechanisms a predetermined time period prior to initiating actuation of the other of the first and second mechanisms to achieve the simultaneous reaching of the open and closed states.

19. The method according to claim **18** wherein actuation of the first mechanism is initiated prior to actuation of the second mechanism.

20. The method according to claim **19** wherein the predetermined time period is approximately 1 to 3 seconds.

21. The method according to claim **7** wherein step D comprises moving the outlet vanes to a position for discharging air in a forward direction perpendicular to a plane of the outlet.

22. A room air conditioner comprising a housing forming an air inlet for receiving incoming room air, and an air outlet for discharging the air back into the room, a plurality of outlet vanes extending across the outlet and being mounted for swinging movement to be adjustable for varying a direction of flow of discharged air, a motor-actuated outlet vane drive mechanism for swinging the outlet vanes, a heat exchanger disposed between the air inlet and air outlet for changing the temperature of air passing therethrough, an air circulator for circulating air into the inlet, through the heat exchanger and out through the outlet, an inlet closure in the form of swingable inlet vanes for closing the inlet, an outlet closure for closing the outlet, a motor-driven first mechanism for moving the inlet closure between open and closed states, a motor-driven second mechanism for moving the outlet closure between open and closed states, a sensor arranged for sensing a position of the outlet closure prior to that closure reaching a closed state, and a controller connected to the second mechanism and the sensor for actuating the second mechanism for a predetermined period after the sensing of the outlet closure during and outlet closure closing operation.

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